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ABSTRACT

A suburban Chicago, Illinois, high school administrator and several of her family members initiated an interdisciplinary curriculum in the mid-1990s. As the program grew, she began a systematic study to evaluate its impact on student learning and behavior and on teacher attitudes. A subsequent research partnership with the Illinois Mathematics and Science Academy resulted in a 4-year study tracking the first graduating class of students educated under the program and contrasting them with students in the school's discipline-based program. The study focused on members of the class of 2000, tracking academic performance measures, such as grade point average and standardized test scores, and behavioral measures, such as attendance, tardiness, and days suspended. Data were gathered for 161 discipline-based and 247 interdisciplinary students. After adjusting for racioethnic and gender differences, students in the interdisciplinary program demonstrated more positive behaviors than the discipline-based students, as indicated by consistently lower absence rates and generally lower suspension rates. Academic performance indicators also favored the interdisciplinary students, and there was no indication of a "dumbing-down" of interdisciplinary content. Freshman year scores on the Iowa Test of Educational Development were equal or higher, and interdisciplinary students consistently had higher grade point averages. ACT college admissions test scores were also higher for interdisciplinary students. The attrition rate was lower for the interdisciplinary program, and students and teachers expressed positive feelings about the program. (SLD)

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A Four-Year Contrast between High School Students in Interdisciplinary and Discipline-Based Curriculum Programs: Behavioral and Academic Implications

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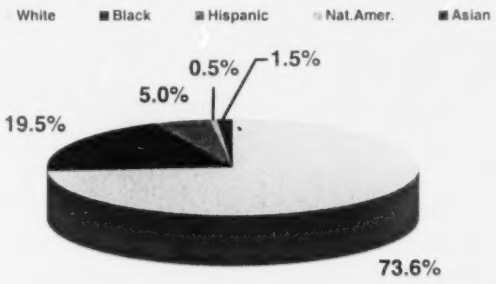
Introduction

A suburban Chicago high school administrator and several of her faculty members initiated an interdisciplinary curriculum program in the mid-1990's. As the program grew, she began a systematic study to evaluate its impact on student learning and behavior as well as on teacher attitudes. A subsequent research partnership with the Illinois Mathematics and Science Academy (IMSA) led to a four-year study tracking the first graduating class of students that were educated under the program and contrasting them with students in the school's discipline-based program.

Background

The high school is comprised of almost 1700 students, with a racioethnic profile of 73.6% White, 19.5% Black, 5.0% Hispanic, 1.5% Asian, and .5% Native American. It is one of three comprehensive high schools in the district.

Racioethnic Composition of Shepard High School



The interdisciplinary effort began in 1993 when the school became eligible for a small Chapter One Program grant for academically at-risk students. A team of faculty members and administrators decided that a new approach was warranted to meet the needs of this segment of the student population. Concurrently, this team applied to participate in the Association for Supervision and Curriculum Development (ASCD) Interdisciplinary Teaching and Learning Consortium, jointly sponsored by ASCD and IMSA. Acceptance into this consortium marked the beginning of the interdisciplinary program.

The implementation began with considerable research and time devoted to staff development, focusing on the following areas: learning styles, interdisciplinary curriculum design, assessment and curriculum planning, multiple intelligence research, team building, conflict resolution, change process, meeting strategies, cooperative learning, brain research, block scheduling, and motivation.

The program began with a facilitator/coordinator and four teachers who shared the same 48 Chapter One students for two of their five-period teaching load. The program integrated English 1, Algebra, World History, and Biology through themes, concepts, skills, and strategies. Subsequently, the facilitator/coordinator was utilized as a tutor for the students, facilitating the replacement of the remedial approach with a more accelerated and challenging curriculum.

As the program developed and the staff perceived positive outcomes, ideas emerged for enhancing the level of integration and expanding the program to other students, thus erasing the perception that it was an "at risk" program. Hence, the interdisciplinary program was expanded to mainstream students, including an honors group, in the following year.

Each year's expansion was predicated by the increased volunteering of teachers for the program. Currently, program participants included 646 freshman, sophomore, and junior-level students, as well as 39 teachers from various disciplines serving on 14 interdisciplinary teams.

Literature Review

Proponents of an interdisciplinary curriculum generally maintain that it has greater real-life relevance and therefore is more meaningful to the student than discipline-based curricula. According to Everett (1992), an interdisciplinary curriculum allows students to learn as they would in the real world. She also believes that such an approach enables a teacher to be student-centered as well as subject-centered, thus promoting greater student participation and shared decision-making. Hackmann and Waters (1998) cite various studies finding that schools with the innovative scheduling inherent in interdisciplinary programs often report improvement in attendance, disciplinary problems, students completing advanced placement courses, mastery of content, and grades.

In contrast, others have questioned such interdisciplinary learning for its focus on connections at the expense of content. Gardner (1999) argues that use of the term "interdisciplinary" assumes the mastery of discipline content. He believes that pre-collegiate students initially must be immersed in a discipline-based approach to learning in order master the knowledge necessary to pursue genuine interdisciplinary work.

Research Methodology

The study focused on students who were members of the Class of 2000, tracking both the initial members of the class as well as subsequent enrollees over the course of their high school careers. It compared the interdisciplinary students to the discipline-based students using the following quantitative measures:

- academic performance measures: overall GPA, senior year GPA (inasmuch as there are no interdisciplinary classes for seniors), freshman year scores on the Iowa Test of Educational Development and its subsections, percentages of students taking ACT college admissions tests, ACT scores, and on-time graduation rates; and
- behavioral measures: attendance, tardiness, and days suspended.

Although approximately three-fourths of the students were enrolled for the entire year, days absent, times tardy, and days suspended were weighted for number of days attended (e.g., four days absent for 88 days attended were extrapolated to eight days absent for the a hypothetical year's attendance). The weighted analyses produced only small differences in the findings when contrasted to analyses using unweighted data.

In order to compensate for any compromises in the otherwise random assignment of students due to scheduling constraints, the intervening effects of race and gender also were examined. Due to small numbers in some minority groups, Blacks, Hispanics and Native Americans were clustered into an academically underrepresented groups category; Whites and Asians were clustered as the counterpart; the academically overrepresented groups category. Socioeconomic status data,

which often are highly related to racioethnicity, were not available. Hence, racioethnic findings may be attributable at least in part to underlying socioeconomic status.

The above quantitative data were augmented with focused interviews of teacher and student participants in the interdisciplinary program.

Limitations

School-based research designs usually are restricted in terms of their ability to both measure all possible dimensions of change and control for potential compromises to validity. These concerns are compounded when the researcher is brought into a study already in progress, as was the case in this setting.

- Teacher participation in the interdisciplinary program occurred through self-selection. Some differences found between programs could be explained by preexisting differences in the teachers rather than the curriculum. Such differences also may affect grading standards, which in turn would affect GPA for the freshman through junior years.
- Initial student assignment to each program largely was randomized, limited only by scheduling restrictions. Nevertheless, significant differences between the two groups in terms of racioethnicity and gender were found in the student records database. Such differences were expected to favor the interdisciplinary program, since that program's higher levels of females and White/Asian students traditionally have higher GPA's and fewer recorded days suspended than males and Blacks/Hispanics. Statistical techniques to adjust for the inequalities only accommodated differences for which data were kept (for example, there was no eighth-grade GPA data).

  There was no racioethnic or gender data in the Iowa test database, but the availability of pretest data demonstrating minimal differences largely eliminated inequality concerns for this comparison.
- Due to programming/database limitations, for the first three years, data for each academic year included only students still enrolled at the beginning of the subsequent school year. Data on dropouts and students being held back a grade were available only for the senior year.
- The setting is likely to generate a Hawthorne effect. The extra attention and interaction experienced by the interdisciplinary teachers in the implementation of a new program may enhance their performance regardless of the merits of an interdisciplinary curriculum. Such enhancement may in turn affect the performance of their students. Novelty effect also may enhance initial teacher and student performance. The passing of time inherent in a longitudinal approach should minimize such effects.
- The quantitative data were augmented with interviews of interdisciplinary teachers and students. However, no comparisons of attitude (e.g., via surveys) were conducted between the interdisciplinary and non-interdisciplinary students.
- Neither the Iowa nor the ACT is designed to focus on the integrative thought processes fostered by an interdisciplinary curriculum. Such tests tend to focus on content accumulation rather than on understanding and problem-solving. Hence, the integrative benefits of the interdisciplinary curriculum may be measured minimally, while its primary potential weakness will be scrutinized. Consequently, expectations for these more traditional

measures should be to find no difference between the two groups; i.e., that there is "no harm done" in terms of content learning for the interdisciplinary students.

Findings

Analyses of Iowa Test Comparisons

The thirteen scores from the Iowa Test of Educational Development (ten subscores, two area composites, and an overall composite score) comprised one of the two sets of data for quantitative analysis. Four sections of the Class of 2000 (an interdisciplinary regular class, a discipline-based regular class, an interdisciplinary honors class, and a discipline-based honors class) were tested at the beginning and end of the 1996-1997 academic year. The large difference in academic performance levels between the honors and regular students resulted in the use of two sets of analyses. The first was a contrast between students from the interdisciplinary regular class and the discipline-based regular class, and the second was between interdisciplinary honors and discipline-based honors.

The differences for initial scores between the interdisciplinary regular and discipline-based regular students were minimal, with composite score means of 249.0 and 247.7, respectively. The initial differences between the interdisciplinary honors and discipline-based honors were slightly larger, with composite score means of 291.8 and 285.6, respectively. Although none of the differences for the thirteen sets of means were statistically significant, analyses of covariance (ANCOVA's) were used for the comparisons to adjust for the generally slightly higher initial interdisciplinary student scores.

Test scores for both groups showed significant increases for most test scores. The graph, "Freshman Pre- and Post-Test Scores on the Iowa Test" of Educational Development: 09/96 - 05/97, in the Appendix, illustrates these changes. Each column corresponds to a test item, area composite, or overall composite score, with the leftmost marker denoting the pretest and the right one the posttest.

The ANCOVA's demonstrated that one of the ten individual adjusted final score means, interpreting literary material, was significantly higher for the interdisciplinary regular class contrasted with the traditional regular class ($p = .004$; η^2 [eta squared, an estimate of the amount of variance explained] = .084). Although unequal variances and sample sizes would reduce the significance of this contrast, the level almost certainly would remain significant (unequal variance post hoc tests are not available for dichotomous ANCOVA contrasts in the SPSS statistical package). Similarly, two of the adjusted final scores, quantitative-advanced skills and quantitative thinking, were significantly higher for the interdisciplinary honors class than the traditional honors class ($p = .009$; $\eta^2 = .079$ and $p = .023$; $\eta^2 = .062$, respectively). None of the composite scores showed significant differences for either the regular or honors student contrasts. Hence, these end-of-freshman-year measures, even when adjusted for small between-group differences, showed that the interdisciplinary classes demonstrated generally equal but occasionally superior performance.

Analyses of Interviews of Interdisciplinary Students and Teachers

In the interviews conducted at various times through the years, interdisciplinary teachers and students reported a variety of positive attitudes toward the program. Interdisciplinary students reported increased levels of a variety of positive learning environment attributes, many of which matched the intended goals of the program:

- feelings of empowerment;
- acceptance of responsibility for own behavior and performance;
- risk-taking in class;
- team building skills;
- increased difficulty, variety and complexity of assignments;
- opportunity for use of different ways of thinking;
- strategies that appeal to a variety of learning styles;
- project focus;
- authentic tasks and assessments;
- creative lesson plans;
- social interaction and comfort level with peers;
- time on task, focus, and productivity;
- skill proficiency in notetaking, semantic mapping, communication [speaking, listening, and writing], content area reading strategies, study skills, and working independently;
- teacher concern for and interaction with students;
- teachers working with each other;
- parental involvement;
- classes being perceived as more student-centered and interactive; and
- utilization of technology.

The increased blocks of class time were mentioned as fostering many of the above positive attributes. The interdisciplinary students had no general negative comments specific to the program.

Teachers were asked to comment on the advantages and disadvantages of working in the integrated block. The reported advantages were:

- larger blocks of time enhanced efficiency, inasmuch as activities (e.g., labs, projects, covering themes and concepts) can be introduced, completed, and reviewed in the same day;
- collaboration provided support, promoting enthusiasm and growth;
- collaboration produced better solutions to problems, particularly relative to individual students; and
- larger blocks of time produced stronger relationships with students.

The disadvantages were:

- excessive familiarity among students (e.g., engaging in personal conversations during class),
- students who did not assume responsibility for make-up work, and
- extra time needed for planning.

In general, the teachers expressed that they did not want to return to the relative alienation and isolation of a traditional class setting after experiencing the integrated block teams.

Analyses of Behavioral and Academic Performance Data by Each Year's Participants

The initial t-test analyses demonstrated that the Class of 2000's interdisciplinary students had significantly higher GPA's, rates of taking the ACT, and rates of senior graduation; as well as lower rates of days absent, times tardy and days suspended for each year (except for senior year days suspended), as indicated by the chart below.

Please note that since there is no interdisciplinary program for seniors, the program classification for the final year was taken from the prior year's database. Also, the GPA's (as well as ACT scores and percent taking them) are cumulative, whereas the behavioral measures are contrasted on a per-year basis. Furthermore, there was no differentiation made for the first three years in terms of whether students transferred to another school or dropped out of school. This was done for their senior year, although in the chart below, it is reported in terms of whether or not students who started their senior year graduated.

Comparisons between Program Means

(boldfaced data cells indicate statistically significant findings at the $\alpha = .05$ level)

	1996-1997		1997-1998		1998-1999		1999-2000	
	Discipline-based ($n = 303$)	**Interdisciplinary** ($n = 158$)	**Discipline-based** ($n = 228$)	**Interdisciplinary** ($n = 202$)	**Discipline-based** ($n = 161$)	**Interdisciplinary** ($n = 247$)	**Discipline-based** ($n = 161$)	**Interdisciplinary** ($n = 247$)
CumulativeGPA	**2.91**	**3.64**	**3.00**	**3.79**	**3.15**	**3.71**	**3.21**	**3.79**
Senior Yr GPA	not applicable						**3.37**	**4.02**
Days Absent*	**14.0**	**8.2**	**13.4**	**7.7**	**15.1**	**9.5**	**24.8**	**14.7**
Times Tardy*	**1.2**	**.6**	**1.6**	**1.1**	**4.1**	**2.3**	**3.8**	**2.7**
Days Suspended*	**.7**	**.2**	**.7**	**.2**	**.5**	**.3**	.4	.3
% Graduating**	data not available						**63.6%**	**85.0%**
% Taking ACT	not analyzed ($n = 1$)				**23.6%**	**54.3%**	**31.1%**	**65.6%**
ACT scores	not analyzed ($n = 1$)				20.8	21.1	20.1	20.8

* weighted by # of days attended ** % enrolled at the beginning of their senior year who were not being held back or dropping out; excludes transfers

Almost all of the findings were highly statistically significant, as detailed by the chart below. Levels for η^2 were included to display an estimate of the amount of variance explained by the relationships.

Differences between Programs

(boldfaced data cells indicate statistically significant findings at the $\alpha = .05$ level)

	1996-1997	1997-1998	1998-1999	1999-2000
	p (η^2)	p (η^2)	p (η^2)	p (η^2)
CumulativeGPA	**< .0005 (.114)**	**< .0005 (.162)**	**< .0005 (.075)**	**< .0005(.069)**
Senior Yr GPA	not applicable			**< .0005(.052)**
Days Absent*	**< .0005 (.044)**	**< .0005 (.075)**	**< .0005 (.067)**	**< .0005(.092)**
Times Tardy*	**< .0005 (.021)**	**.028 (.011)**	**.001 (.036)**	**.025 (.013)**
Days Suspended*	**< .0005 (.062)**	**< .0005 (.062)**	**.044 (.011)**	.219 (.004)
% Graduating**	data not available			**< .0005(.061)**
% Taking ACT	not analyzed ($n = 1$)		**< .0005 (.092)**	**< .0005 (.114)**
ACT scores	not analyzed ($n = 1$)		.783 (.0004)	.389 (.003)

* weighted by # of days attended ** % of students enrolled at the beginning of their senior year who graduated

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Note that while the difference between ACT scores was not significant, the percentage of interdisciplinary students taking the ACT was more than double that for discipline-based students (a highly significant difference).

However, differences were found between the program in terms of gender and race. The traditionally underrepresented groups (Blacks, Hispanics, and Native Americans) were underrepresented in the interdisciplinary program, particularly in the 1996-1997 and the 1997-1998 years. Also, males were somewhat underrepresented in the interdisciplinary program all three years. Hence, it was necessary to factor out these demographic differences to determine whether the academic performance and behavioral measures were due to program differences or simply an artifact of racioethnicity and gender.

The three-way ANOVA's, controlling for the effects of race and gender, indicated that the interdisciplinary program students demonstrated generally more positive behaviors to a statistically significant degree for most measures, as illustrated in the chart below.

Differences between Programs, Factoring for Racioethnicity and Gender

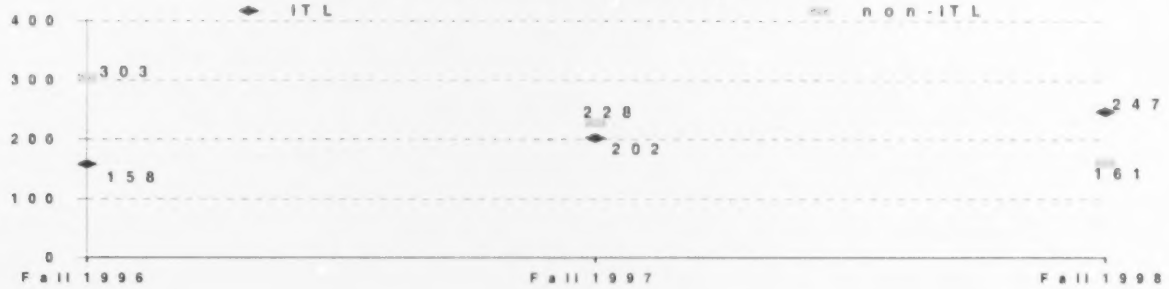
(boldfaced data cells indicate statistically significant findings at the $\alpha = .05$ level)

	1996-1997	1997-1998	1998-1999	1999-2000
	p (η^2)	p (η^2)	p (η^2)	p (η^2)
Cumulative GPA	**< .0005 (.038)**	**< .0005 (.095)**	**< .0005 (.047)**	**< .0005 (.043)**
Senior Yr GPA		not applicable		**< .0005(.034)**
Days Absent*	**.002 (.021)**	**< .0005 (.050)**	**< .0005 (.060)**	**< .0005(.083)**
Times Tardy*	**.010 (.015)**	.176 (.004)	**.015 (.015)**	.392 (.002)
Days Suspended*	**.005 (.017)**	**< .0005 (.048)**	.065 (.008)	.504 (.001)
% Graduating**		data not available		**< .0005 (.053)**
% Taking ACT	not analyzed ($n = 1$)		**< .0005 (.083)**	**< .0005 (.102)**
ACT scores	not analyzed ($n = 1$)		.752 (.001)	.561 (.002)

* weighted by # of days attended ** % of students enrolled at the beginning of their senior year who graduated

The above charts were affected by shifting enrollments between the programs, as well as by dropouts and transfers in and out of the programs to other schools. The significant growth demonstrated by the interdisciplinary program, and the shrinkage shown for the discipline-based one, are illustrated in the chart below.

Enrollment Levels in Each Program



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Analyses of Behavioral and Academic Performance Data for Initial Enrollees in Each Program

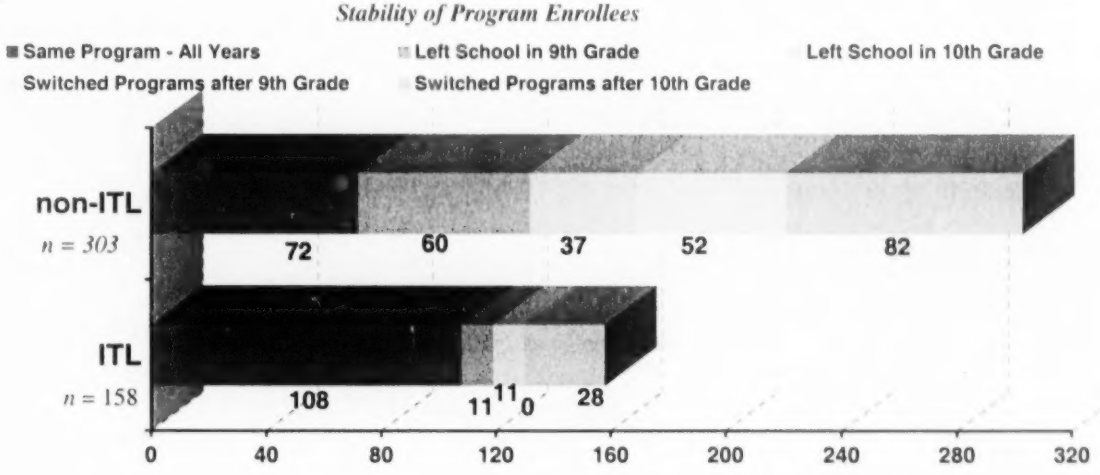
Although the above year-to-year contrasts indicate higher-level performance in the interdisciplinary program, student transience across years (both between programs and out of the school) affects the ability to isolate the effects of the program. Hence, a second set of analyses were conducted tracking only the students who were initially enrolled in each program. As mentioned earlier, there were no specific data available on whether the students had dropped out of school entirely or merely transferred to another during their sophomore or junior year (no freshman year attrition data of any kind were available). Data specifying transfers and dropouts were available for the senior year. The following highlights the most meaningful information:

- For the interdisciplinary students, 108 of the original 158 (68.4%) stayed in the program throughout its three years. Ninety-eight of the 108 (90.7%) graduated from Shepard High school in 2000, with two not yet graduating and eight dropping out during their senior year.

  Eleven of the initial 158 left the school during their sophomore year and another 11 during their junior year. Although none transferred from the interdisciplinary program to the discipline-based program after their freshman year, 28 of the original 158 transferred after their sophomore year. This increase in transfers was attributed to the limited honors scheduling at the junior level in the interdisciplinary program.
- In contrast, 72 of the original 303 (23.8%) stayed in the discipline-based track program throughout the first three years. Forty-five of the 72 (62.5%) graduated from Shepard High school in 2000, with one transferring out of Shepard, 15 not yet graduating, and 11 dropping out during their senior year.

  Sixty left the school during their sophomore year and another 37 during their junior year. Also, 52 of the original 303 transferred from the discipline-based program to the interdisciplinary program after their freshman year (12 of them transferred back after their sophomore year, possibly due to the limited honors offerings) and 82 more transferred to the interdisciplinary program after their sophomore year.

The shifts are represented in the chart below.



Many of those who stopped attending Shepard prior to the beginning of their senior year probably were dropouts (who generally would have higher levels of discipline problems and lower levels of academic performance) rather than transfers. A check of those who left shows that they demonstrated significantly less positive levels for GPA, attendance, tardies, and days suspended for the years during which they were enrolled (p-values ranging from .006 to <.0005). Since the percentage of such dropout/transfer students was greater for the discipline-based program, their numbers of potentially low-achieving and discipline problem-prone students probably were reduced disproportionately in subsequent years. In other words, the differences between the discipline-based and interdisciplinary programs were diminished in subsequent years by such attrition.

As mentioned above, differences in the effect of programs on student learning and behavior would be most pronounced for students who had stayed with each program throughout the three years of separate programming. Hence, the most valid analyses of contrasts in terms of differentiating the effects of the programs are represented in the table below (and in the graphs in the Appendix, page 2).

Differences between Persisters Across All Years in Each Program, Factoring for Racioethnicity and Gender
(boldfaced data cells indicate statistically significant findings at the $\alpha = .05$ level)

	p (η^2)
Cumulative GPA	**< .0005 (.163)**
Senior Year GPA	**< .0005 (.148)**
Days Absent*	**< .0005 (.099)**
Times Tardy*	.595 (002)

	p (η^2)
Days Suspended*	**< .0005 (.110)**
% Graduating**	**< .0005 (.085)**
% Taking ACT	**< .0005 (.290)**
ACT scores	**.040 (.042)**

* weighted by # of days attended ** % of students enrolled at the beginning of their senior year who graduated

The percentage of persisting interdisciplinary students taking the ACT was 81.5%% versus only 25.0% for discipline-based students. Additionally, the interdisciplinary students had marginally significantly higher ACT scores.

Conclusion

The following conclusions have emerged from the research study:

- Even after adjusting for racioethnic and gender differences, students in the interdisciplinary program demonstrate more positive behaviors than the discipline-based students, as indicated by the consistently lower absence rates and generally lower suspension rates. Findings on tardies are less clear-cut, although differences consistently favor the interdisciplinary students.
- The academic performance indicators also favored the interdisciplinary students, with no indication of a "dumbing-down" of interdisciplinary curricular content.
  - Their freshman year scores on the Iowa Test of Educational Development were equal or higher.
  - Although there is no way to be sure that the grading standards for the two programs are equal, interdisciplinary student overall GPA's were consistently higher. For the senior

year, when there was no longer an interdisciplinary program and both sets of students were being graded by the same teachers, the difference in GPA was particularly meaningful. Those students who had gone through the interdisciplinary program continued to have significantly higher grades.

  - The ACT data indicate a definite interdisciplinary student superiority, with a much higher percentage of students taking the test as well as slightly higher scores.
  - Senior year data indicate that students from the interdisciplinary program were more likely to graduate and less likely to have dropped out their senior year.
- The attrition rate for the interdisciplinary program has been much lower. The interdisciplinary students were much more likely to stay with their original program than the discipline-based students. Interviews reinforced these quantitative findings, with the interdisciplinary students expressing a preference for their current classes over past discipline-based ones.
- Interdisciplinary teachers expressed a strong preference for their current teaching experience over prior non-integrative ones.

The final question that remains is whether the curriculum can be credited with the apparent positive aspects of the interdisciplinary students and teachers. The teacher self-selection into the program, novelty effect of new experiences, and the extra attention paid to an innovation, were factors that initially may have provided an edge to interdisciplinary teacher and student performance measures. However, as the study continued, the novelty diminished and the measures became longer-term. Furthermore, the students and teachers seem to be benefiting from the program, regardless of the reason. Hence, the cumulative four-year positive findings solidly support the continuation of this interdisciplinary experiment at the high school, and indicate that other schools might want to emulate the program.

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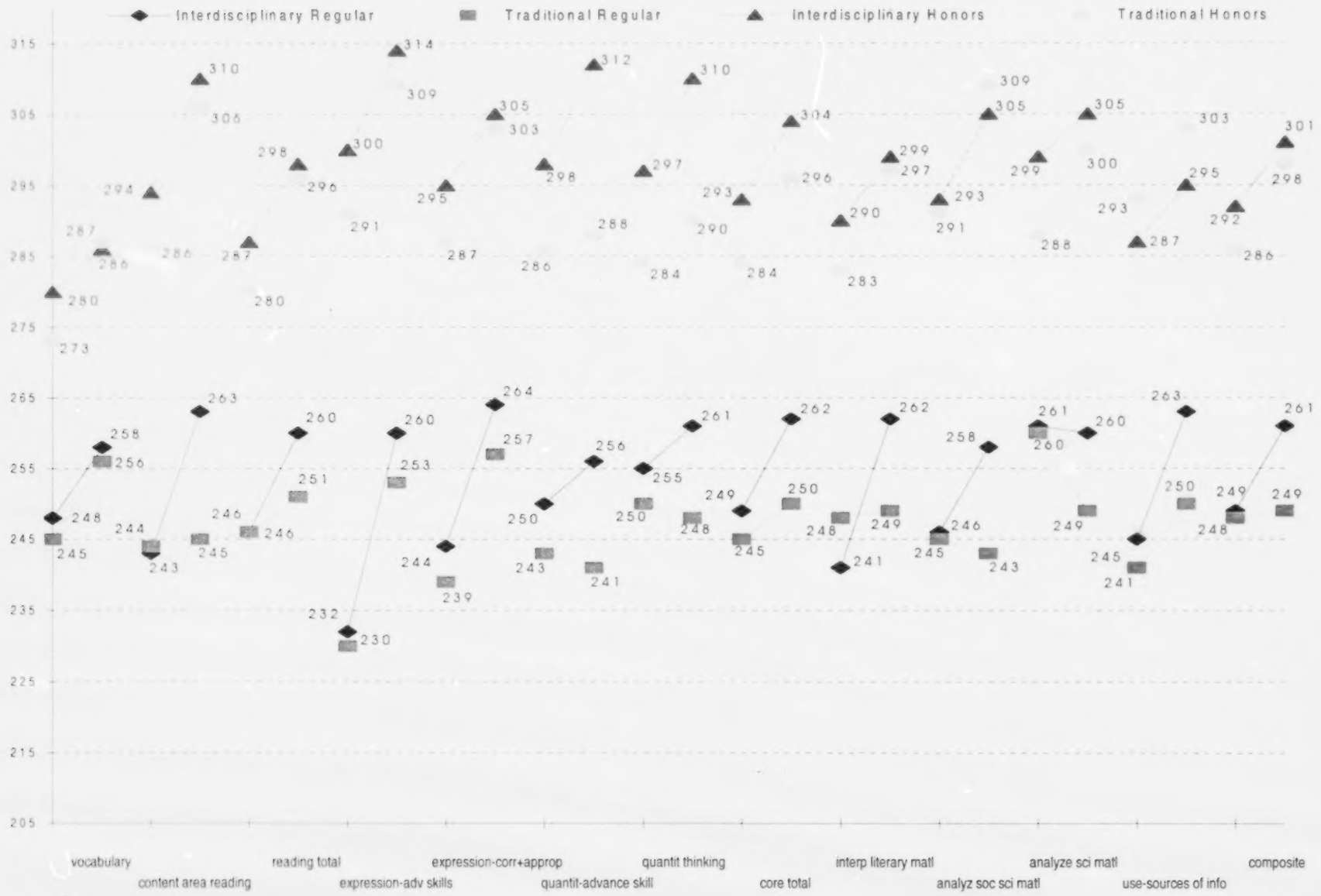
Appendix

Freshman Pre- and Post-Test Scores on the Iowa Test of Educational Development: 09/96 - 05/97



Graphs Contrasting Shepard High School Students Enrolled Exclusively in Interdisciplinary or Discipline-Based Programs throughout Four Years of High School

(significance tests adjusted for differences in underrepresented racioethnic groups and gender)